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TOBACCO EXPERIMENTS IN SOUTHERN OHIO

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TOBACCO EXPERIMENTS IN SOUTHERN OHIO

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Experiments in burley tobacco production were initiated in 1958 at the Southern Substation of the Ohio Agricultural Experiment Station, about 4 miles northeast of Ripley, Ohio, at the northern edge of the burley belt. These experiments were designed to provide information on the response of burley tobacco to various fertility levels and cultural practices under conditions in Southern Ohio. Production, handling, and curing of tobacco grown on the experimental plots were similar to methods employed by farmers in the area.

NITROGEN, PHOSPHORUS, AND POTASSIUM STUDIES

Three separate field experiments were conducted to measure response to three main fertilizer elements, nitrogen, phosphorus, and potassium. Nitrogen fertilization was studied in conjunction with irrigation in a split plot design. Irrigation variables were applied to the whole plots and nitrogen variables to the sub-plots. The experiment was replicated three times. Data presented here concerns only nitrogen rates which were obtained from the non-irrigated plots. Results of the irrigation study and nitrogen-irrigation interactions are presented elsewhere (2). Phosphorus and potassium experiments were arranged in randomized complete blocks with 4 replications.

Fertilizer Treatments

Three rates of nitrogen (60, 120, and 180 pounds N per acre) and four rates of phosphorus and potassium (60, 120, 180, and 240 pounds P_2O_5 per acre and 80, 160, 240, and 320 pounds K_2O per acre) were included in these experiments. Adequate amounts of the fertilizer element not under study were applied to each plot. These amounts were 120 pounds of N, 240 pounds of P_2O_5, and 320 pounds of K_2O. All potassium was supplied in the sulfate form. In 1962 the N rate was increased to 150 pounds per acre for the highest P and K treatments.

General Experimental Conditions

Plants were produced in both burned and chemically treated beds each year to insure an adequate supply of healthy plants for experimental plots No effort was made to compare methods of plant bed sterilization on an

[1]Grateful acknowledgment is made by the authors to Mr. William Wilson, manager of the Southern Substation, for his help in conducting these experiments; Dr. G. S. Taylor for writing computer programs used in statistical analysis of the data; and the Department of Agronomy, University of Kentucky, for performing total alkaloid analyses.

experimental basis since this has been extensively covered by other workers (8). Plant beds were treated with 30 pounds of 5-10-15 fertilizer per 1000 square feet of bed and in the fall a green manure crop of soybeans was plowed under. This method resulted in production of vigorous, healthy plants by setting time. Plants were set during the first two weeks of June with a one-row, tractor mounted transplanter. Each plot was 50 feet in length and contained 5 rows at 18 inch intervals with 40 inch spacing between rows, except where row spacing was being studied. The experimental plots contained 5 rows.

Tobacco was topped when 1/2 to 2/3 of the plants were showing bloom; later all except the two top suckers were removed. The two top suckers were removed at harvest time. One one-hundredth of an acre from the three center rows was harvested and the cured tobacco usually stripped into four grades. Tobacco was graded by a federal inspector and each grade weighed to determine yield. Leaf samples for chemical analyses were obtained by random sampling from each grade.

Experimental plots were maintained in a three year rotation of small grain, meadow, and tobacco.

Description of Soils and Rainfall

The nitrogen experiment was conducted on a Loudon silt loam in 1959 and 1962, and on an Avonburg silt loam during the remaining years. Both soils had a similar level of fertility. The pH was approximately 5.0, the organic matter content 2 percent, and soil tests indicated 100 pounds of P_2O_5 and 250 pounds of K_2O. Phosphorus and potassium experiments were conducted on a Loudon silt loam in 1960 and on an Allensville silt loam during the remaining years. These plots were located on an area having considerably less available P and K during the period 1960-1962 than during the previous years. This can be ascertained from soil test results in Table 1.

Rainfall distribution for 10 day intervals during the growing season is shown in Table 2. The accumulated rainfall from October of the previous season to May of the given year is also shown. Rainfall was was such during the years 1958-1962 that yields did not appear to be limited (2).

Results and Discussions

Yield

Nitrogen applications consistently increased the yield of tobacco, as would be expected (Table 3). The yield increased with increases in N up to the 120 pound rate and then tended to level off. Only in 1961 did a response occur as a result of increasing the rate of N from 120 to 180

TABLE 1.–Soil Test Results for Soils in the Phosphorus and Potassium Experiment.

Year	pH	Organic Matter Percent	Available P Lbs./A*	Available K Lbs./A**
1958	4.9	1.5	194	198
1960	5.7	1.5	6	106
1961	5.5	2.0	15	136
1962	5.9	1.5	18	93

* Based on extraction with 0.03 N NH_4F in 0.025 N HCl.
** Based on extraction with neutral, 1.0 N NH_4OAc.

TABLE 2.–Rainfall Distribution at the Southern Substation During the Period 1958-1962.

Time Interval	1958	1959	1960	1961	1962
			Inches of Rainfall		
June 1-10	2.11	.47	.05	3.38	.59
11-20	1.83	.29	2.58	3.97	.45
21-30	1.12	2.66	2.43	.05	1.93
	5.06	3.42	5.06	7.40	2.97
July 1-10	.92	1.34	4.04	.69	1.83
11-20	3.12	2.77	.42	3.47	1.48
21-31	2.01	2.38	1.07	1.17	1.85
	6.05	6.49	5.53	5.33	5.16
Aug. 1-10	.94	.11	2.22	.47	.83
11-20	1.37	1.27	0.00	.88	.29
21-31	1.50	.29	0.00	.51	.24
	3.81	1.67	2.22	1.86	1.36
Sept. 1-10	.52	1.54	.77	.12	1.59
	1.68	.00	1.57	.14	.32
	2.01	.26	0.00	.11	.33
	4.21	1.80	2.34	.37	2.24
Total for Growing Season	19.13	13.38	15.15	14.96	11.73
Pre-Growing Season (Oct.-May)	28.65	20.06	30.70	28.65	28.09

TABLE 3.–Yield of Tobacco As Affected By the Rate of Fertilization.

Treatment Pounds of Nutrient Per Acre	1958	1959	1960	1961	1962	Average '60-'62	Average All Years
				Pounds Per Acre			
N							
0	2009	1523	1668	1385	1917	1657	1703
60	2142	1634	1821	1670	2136	1876	1886
120	2334	1757	1905	1936	2418	2086	2096
180	2444	1804	1873	2155	2329	2119	2102
LSD .05	129	107	206	145	162	114	88
.01				199	222	150	115
P_2O_5							
0	2186	*	1370	1660	1928	1652	1786
60	2136		1686	1697	2080	1821	1900
120	2112		1719	1730	1946	1798	1877
180	2177		1721	1689	2153	1854	1935
240**	2107		1724	1717	2227	1889	1944
LSD .05	N.S.		258	N.S.	175	136	N.S.
K_2O							
0	2027	*	1729	1307	2421	1819	1871
80	2144		1854	1415	2523	1931	1984
160	2080		1743	1294	2481	1839	1899
240	2177		1973	1460	2515	1983	2031
320**	2075		1838	1439	2674	1984	2006
LSD .05	N.S.		N.S.	N.S.	N.S.	98	82
.01						126	108

*The P and K plots were not harvested in 1959 due to severe wind damage.
**These treatments received an additional 30 pounds N per acre in 1962 (total of 150 pounds per acre).

pounds per acre. Considering the 3 and 5 year averages, there was no increase in yield above the 120 pound rate.

Data were not collected in 1959 from the P and K plots due to severe wind damage. Generally the response to P applications was irregular. In 1960 yield was increased by all rates of P, while in 1962 the yield was increased only by the two higher rates of application. There was considerable variation in relative response to the P and K treatments and therefore an average yield over several years may be more reliable. Averages of the past 3 years are included in the table for comparative purposes due to the high amount of available P and K contained in the soil selected for the 1958 plots. The 3-year average yield was increased about 170 pounds per acre by the addition of 60 pounds of P_2O_5 per acre. There were no differences among any of the P rates.

Potassium did not increase the yield in any one year although considering the 3 year and 5 year averages, yield was increased about 110 pounds by the application of K. As was the case with P, there were no differences between the rates of application. Potassium deficiency symptoms were often observed on plots receiving no potassium. It is unusual that there was not a greater yield response to K applications.

The tendency for the acre value to increase (not significantly) with the highest rates of both P and K may have been due to the application of an additional 30 pounds of N per acre with these treatments in 1962. This had been done to determine whether the rate of N (120 pounds per acre) being applied to the P and K plots was sufficient. The appearance of the tobacco in tests other than where N rates were studied suggested that 120 pounds of N per acre was not sufficient. This matter is being investigated.

Acre Value and Quality

Acre value was computed using the average market price for each grade at the end of the particular season and the yield for each grade. The product of the yield and the price represents the value of each grade. The sum of the values for all grades when adjusted according to the plot size gives the acre value. The price per 100 pounds which will be referred to as price, is simply the acre value divided by the total yield and serves as an index of quality.

The response to N, P, and K as measured by acre value followed closely the same trends which were observed for yield (Table 4).

The price of the leaf was increased from $1.00-2.00 per 100 pounds by the addition of 120 pounds of N (Table 5). Potash generally increased the quality of the leaf as can be seen from the increase in value per 100

TABLE 4.—Effects of Various Fertilizer Treatments on the Acre Value of Burley Tobacco.

Treatment Pounds of Nutrient Per Acre	1958	1959	1960	1961	1962	Average '60-'62	Average All Years
			Dollars Per Acre				
N							
O	1383	1023	1124	928	1252	1101	1142
60	1472	1108	1259	1135	1432	1275	1279
120	1579	1180	1312	1343	1638	1431	1430
180	1639	1209	1292	1487	1579	1453	1432
LSD .05	88	82	160	108	119	84	67
.01			219	148	163	110	88
P_2O_5							
O	1518	*	923	1120	1265	1103	1207
60	1483		1174	1132	1367	1224	1289
120	1468		1198	1167	1271	1212	1276
180	1515		1203	1125	1396	1241	1310
240**	1464		1200	1148	1455	1268	1317
LSD .05	N.S.		.85	N.S.	119	99	N.S.
.01							
K_2O							
O	1374	*	1162	824	1509	1165	1217
80	1467		1278	908	1639	1275	1323
160	1427		1207	830	1616	1217	1270
240	1496		1377	951	1667	1332	1373
320**	1430		1289	944	1791	1341	1363
LSD .05	N.S.		N.S.	N.S.	54	73	62
						96	81

*The P and K plots were not harvested in 1959 due to severe wind damage.
**These treatments received an additional 30 pounds N per acre in 1962 (total of 150 pounds per acre).

TABLE 5.—Value Per 100 Pounds of Burley Tobacco As Affected By Fertilizer Treatment.

Treatment Pounds of Nutrient Per Acre	1958	1959	1960	1961	1962	Average '60-'62	Average All Years
			Dollars Per 100 Pounds				
N							
0	68.9	67.3	67.3	66.8	65.3	66.4	67.0
60	68.8	67.9	69.1	67.7	67.0	67.9	67.8
120	67.7	67.2	68.8	69.1	67.5	68.5	68.2
180	67.0	66.9	68.9	69.0	67.8	68.6	67.9
LSD .05	N.S.	N.S.	1.4	1.8	1.1	0.8	0.8
.01					1.5	1.0	1.1
P_2O_5							
0	69.5	*	67.2	67.0	65.6	66.6	67.3
60	69.4		69.6	66.7	65.7	67.3	67.9
120	69.5		69.7	67.4	65.3	67.4	68.0
180	69.6		69.9	66.4	64.8	67.1	67.7
240 **	69.5		69.6	66.9	67.0	67.8	68.2
LSD .05	N.S.		0.9	N.S.	N.S.	N.S.	N.S.
K_2O							
0	67.8	*	67.1	63.0	62.2	64.1	65.0
80	68.4		68.9	64.1	64.9	66.0	66.6
160	68.6		69.1	63.9	65.1	66.1	66.7
240	68.7		69.8	65.1	66.3	67.0	67.4
320 **	68.9		70.1	65.5	66.9	67.5	67.9
LSD .05	N.S.		1.2	1.4	2.2	0.9	0.7
.01			1.7		3.0	1.1	0.9

*The P and K plots were not harvested in 1959 due to severe wind damage.

** These treatments received an additional 30 pounds N per acre in 1962 (total of 150 per acre).

pounds. This increase did not occur in 1958 when the plots were located on the soil testing higher in available K. Although this improvement in quality did occur it was not sufficient to increase the acre value in 1960 and 1961. This was partly due to the narrow price differential between grades which has existed during the past few years. As an example, the 180 pound rate of N consistently resulted in a poorer quality of leaf as compared to the 120 pound rate based strictly on appearance. The market price did not reflect this trend.

A summary of the yield, acre value, and price data is shown in Table 6. In brief, the optimum rates appeared to be 120 pounds N, 60 pounds P_2O_5, and 80 pounds K_2O per acre.

Chemical Composition

The midribs were removed from the composite sample taken at harvest and the ground leaf analyzed for chemical constituents . Concentration of total alkaloids, Ca, K, N, P, and Mg in the leaf are reported in Table 6 with the summary of yield, value and price data. The values shown are 3-year averages for the period 1960-1962.

As would be expected the addition of nitrogen increased the percentages of total alkaloids and nitrogen in the leaf. The Ca and Mg percentages in the leaf also increased with the application of N while P tended to decrease. The K content was not affected by the rate of N fertilization. These observations are in general agreement with those of Nichols, *et. al.* (5). These authors did, however, observe a decrease in K content of tobacco as N application increased. The K decrease was attributed to a dilution effect as a result of yield increases and the Ca increase was then related to Ca and K competing for absorption sites on the plant root. The decrease in K content occurred here only in 1962 and as mentioned above the 3-year average does not show an effect of N on K content. A possible explanation for the Ca effect lies in the relationship between N content and the cation exchange capacity of the plant roots (4); increasing nitrogen contents were correlated with increasing root cation exchange capacities. In turn, it has been proposed that this property of the plant roots plays a role in the selective absorption of mono and divalent ions, *i. e.* plants with high root exchange capacities tend to absorb greater amounts of Ca in relation to K (3). Laboratory work here has supported this theory. In this work, tobacco plants were subjected to varying concentrations of nitrogen during a growth period to produce plants with varying root cation exchange capacities and then their rates of Ca uptake were measured in short time absorption studies. The absorption of Ca was significantly correlated with the exchange capacities of the roots.

TABLE 6.—Effects of Various Fertilizer Treatments on the Production and Chemical Composition of Burley Tobacco (1960-1962 Average).

Treatment Pounds of Nutrient Per Acre	Yield Lbs./A	Acre Value $/A	Value/100 Lbs. $/100 Lbs.	Alkaloids Percent	Ca Percent	K Percent	N Percent	P Percent	Mg Percent
N									
0	1657	1101	66.4	3.52	4.87	3.13	3.13	0.262	0.686
60	1876	1275	67.9	4.37	5.36	3.18	3.40	.236	.749
120	2086	1431	68.5	4.70	5.92	3.12	3.93	.204	.792
180	2119	1453	68.6	5.29	5.95	3.25	4.22	.222	.804
LSD .05	114	84	0.8	0.42	0.68	N.S.	0.17	.039	.088
P_2O_5									
0	1652	1103	66.6	3.42	6.34	2.68	3.57	.213	.492
60	1821	1224	67.3	3.70	6.54	2.64	3.47	.213	.509
120	1789	1212	67.4	3.36	6.53	2.75	3.27	.217	.493
180	1854	1241	67.1	3.40	6.60	2.85	3.20	.216	.252
240*	1889	1268	67.8	3.50	6.84	2.74	3.20	.221	.513
LSD .05	136	99	N.S.	N.S.	N.S.	N.S.	0.24	N.S.	.030
K_2O									
0	1819	1165	64.1	3.46	7.31	1.47	3.76	.268	.588
80	1931	1275	66.0	3.43	6.91	1.95	3.63	.259	.537
160	1839	1217	66.1	3.41	6.34	2.46	3.56	.240	.525
240	1983	1332	67.0	3.42	6.19	2.68	3.50	.228	.503
320*	1984	1341	67.5	3.30	6.15	2.97	3.49	.210	.514
LSD .05	98	73	0.9	N.S.	0.40	0.22	N.S.	.016	.039

*These treatments received an additional 30 pounds per acre of N as compared to other treatments in the P and K experiments during 1962.

Phosphorus fertilization had little effect on the chemical composition other than lowering the N content. This response has been attributed (5) to comptetition between NO_3^- and $H_2PO_4^-$ for entry into the plant. As will be recalled, this negative relationship was also noted in the N study discussed above. Although the P content tended to increase slightly, the differences were not significant between P treatments. It is interesting that the P applications did not increase the percentage P in the plant in view of the low soil P level (Table 2). The work of Dumenil (1) with N-P relationships in the corn leaf showed that increases in yield and N content may be accompanied by a decrease, increase, or no change in P content depending upon the N-P balance in the plant.

The K treatments had considerable effect on the chemical content of the leaf. Potassium application increased the percentage of K in the leaf but decreased Ca and Mg in an amount almost equivalent to the increase in K. A decrease in phosphorus content was also associated with increasing rate of applied K. The Ca and Mg decreases were probably caused by the competitive effect of K (5). The decrease in P content may have been due to a competitive effect of SO_4 on P absorption since K was added as the sulfate.

Magnesium content of tobacco has recently been associated with quality by Petterson and Tibbits (7). These authors found Mg content to be negatively corrleated with quality of leaf samples. In the experiments being reported, N application resulted in an increase in Mg content while K application resulted in a decrease. There were differences associated with P fertilization but there were no clear cut trends. The quality of the leaf (judged by appearance and value per 100 pounds) shows a positive relationship to Mg for the N treatments and a negati relationship for the K treatments. Assuming a negative correlation between Mg content and quality, Mg would have been an indicator for quality in the K study but may not have been an indicator in the N study. However, the relationship between quality and nitrogen fertilization was not very clear. For instance, the percentage K in the leaf was not affected by N application yet the value per 100 pounds did not reflect what seemed to be an obvious decrease in quality, based strictly on the appearance of the leaf, brought about by increasing the N rate to 180 pounds per acre. It appears that price of the leaf and quality by appearance are not well correlated.

Effect of P and K Application on Soil Test Results

The levels of available P and K as indicated by soil test[2] were followed in order to evaluate the effect of fertilizer applications on the available supply. Samples were taken in the 0-6" layer in the fall after the tobacco was harvested. The soil test P (Table 7) was increased on the average 7 pounds of P per 60 pounds of P_2O_5 applied. This held constant over the range from 0 to 240 pounds of applied P_2O_5. The soil test K increased about 5 pounds of K for each 80 pound increment of K_2O up to the 240 pound rate and then 53 pounds for the last 80 pound increment. Possibly the needs of one of the K fixation mechanisms was becoming satisfied by the 240 pound rate and further addition of K resulted in larger amounts remaining in an extractable form. The lack of yield response to P application in 1961 may have been the result of a slightly higher level of available P.

TABLE 7.—Available P and K According to Soil Test As Affected By Fertilization for the First Year on Three Separate Areas.

Treatment Lbs. P_2O_5 or K_2O/Acre	1960	1961	1962	Average	Net Increase Per Increment of Fertilizer Per Year
			Pounds Per Acre P* or K*		
P_2O_5					
0	8	16	12	12	-
60	19	21	17	19	7
120	30	27	20	26	7
180	23	26	40	30	4
240	33	31	42	38	8
K_2O					
0	122	138	115	125	-
80	129	156	107	131	6
160	150	126	138	138	7
240	143	141	140	141	3
320	204	189	189	194	53

*Available P based on extraction with 0.03 N NH_4F in 0.025 N HCl.
*Available K based on extraction with neutral, 1.0 N NH_4OAc.

[2]Available P and K were determined by extraction with 0.03 N NH_4F in 0.025 N HCl and neutral, 1.0 N NH_4OAc, respectively.

CONTINUOUS CULTURE STUDY

Continuous culture of tobacco is a common, though not recommended, practice in southern Ohio. In some instances continuous tobacco culture is practiced with no apparent production problems. However, too often the sites chosen for growing tobacco in Ohio are poorly drained, not suited to tobacco production, and the yield decreased each year when placed into continuous production of tobacco. This may be due to an increase in disease incidence, decrease in soil structure, or a combination of factors. Several fertility and cultural practices are being compared in an effort to determine ways to counteract the undesirable effects which often result from growing tobacco on the same area year after year.

Experimental Design

The experiment was arranged in a split plot design in which a cover crop and no cover crop are applied as whole plot treatments. Wheat was used as a cover crop in 1960 and 1961 while field brome was grown in 1962. Subplots received 50 pounds of N per acre in addition to the basic treatment but this 50 pound treatment was applied as different sources. The three different sources were commercial fertilizer (NH_4NO_3), manure, and a vetch crop. Manure was applied at the rate of 8 tons per acre. The cover crop and the vetch were planted in the fall. Other treatments were applied in the spring. Basic fertilizer application was 1100 pounds of 5-10-15 fertilizer during the period 1958-1960. During later years additional N was applied so that the total N in the basic treatment amounted to 120 pounds per acre.

The area was planted to tobacco in 1958, and each year since that time. The cover crop treatments were first turned under in the spring of 1960 (an attempt to establish a cover crop the previous year had failed).

The plots were located on an Allensville silt loam. This soil has a silty clay loam upper subsoil and a moderately tight clay loam pan at about 21 inches. General cultural practices were similar to those previously described under the fertilizer experiments.

Results and Discussion

The data reported represent the latter 3 years for the first 5-year period in continuous culture. Yield data were not taken in 1958 and only an average yield for all plots is available for 1959, because of the difficulty in establishing a cover crop until the fall of 1959.

A rotation treatment was not included in the experiment. However, the close proximity of variety test plots which are maintained in a 3-year rotation offer a basis for comparing yields of rotation and continuous

TABLE 8.–Yield of Burley Tobacco from Continuous Plots and Rotation Plots.

Year	Continuous	Rotation
1959	1644	1597
1960	1372	2014
1961	1572	1673
1962	1599	2222

plots. Plots in rotation are separated from the continuous culture plots by a roadway one year in three. Soil is quite similar on the two areas. During the first two years (1958-59) tobacco grown in continuous culture appeared to perform as well as tobacco grown in variety plots under a rotation system. Table 8 shows the yield of plots in the continuous culture experiment and of plots in a rotation (variety test); both receiving about the same fertilizer application. Although data are taken from separate experiments it seems justified to conclude that the yields were lower on the continuous plots for these past 3 years.

The use of a cover crop reduced the average yield 100-275 pounds (Table 9) with the exception of the manured plots. The yield of the manured plots was not significantly reduced by the cover crops as were the yields of other subplot treatments and in 1962 the yield was greatest on the manured plots which received the cover crop. The 3-year yield averages showed significant interaction between the cover crop treatment and subplot treatments. The yield of the vetch plots (both vetch and wheat brome) was affected to a greater extent by the cover crops than were the yields of the NH_4NO_3 and control treatments. The decrease in yield associated with the cover crops might be explained as being due to a complexing of N during the decomposition process. However, yield decrease also occurred when the plots received NH_4NO_3 but not when they received manure. Perhaps the manure is effective in absorbing or in some way inactivating toxic substances which are produced during the decay of plant residues (6).

Effects of these treatments on the acre value, price and on some chemical constituents of the leaf are summarized in Table 10. Data on the acre value follow closely the trends indicated by the yield. The price was greater for the three subplot treatments as compared to the control. The increase in yield, value, and quality probably was caused by the additional N which these plots received and associated with this were increases in the percentage of N, alkaloids, and Ca in the leaf.

TABLE 9.–Yield of Tobacco Produced Under Continuous Culture As Affected By Various Cultural and Fertility Treatments.

Treatment		1960	1961	1962	Average
		Pounds Per Acre			
Cover Crop					
Control		1133	1117	1520	1256
NH_4NO_3		1290	1559	1879	1576
Manure		1444	1744	2123	1770
Vetch		1138	1291	1850	1426
Average		1251	1427	1843	1507
Without Cover Crops					
Control		1217	1206	1678	1367
NH_4NO_3		1455	1586	2007	1683
Manure		1472	1832	1974	1759
Vetch		1327	1590	2117	1678
Average		1330	1554	1944	1609
LSD					
Between Subplots	.05	185	161	84	100
Within Whole Plot	.01	254	221	115	132
Between Cover Crops	.05	N.S.	N.S.	58	61
	.01				
Between Subplots	.05	N.S.	182	91	105
Different Whole Plots	.01			137	139

The addition of a cover crop decreased N, Ca, and total alkaloids. Increases in P and K uptake may have been due to accumulation of K and P in the cover crop and their subsequent release upon decomposition during the growing season.

The maintenance application of fertilizer which was applied each year increased available P and K levels in the soil as measured by soil test (Table 11).

PLANT SPACING STUDY

Five combinations of various row and interrow spacings of tobacco were studied to determine if closer spacing in the rows would compensate for the increased row spacing which might be necessary for mechanical harvesting methods. Experiments were conducted on an Allensville silt loam high in available P and K which has been described previously. Plots were arranged in a randomized complete block with 4 replications.

TABLE 10.—Effects of Various Cultural and Fertility Treatments on the Production and Chemical Composition of Tobacco Produced Under Continuous Culture Since 1958 (Data Represents Summary Over Period 1960-1962).

Treatment	Yield Lbs./A	Value $/A	Price $/100 Lbs.	Alkaloids Percent	Ca Percent	K Percent	N Percent	P Percent
With Cover Crop								
Control	1257	810	64.2	3.18	5.25	2.96	2.92	0.31
NH_4NO_3	1576	1035	65.6	3.87	5.97	3.03	3.36	.26
Manure	1770	1190	67.1	3.79	5.85	3.86	3.25	.24
Vetch	1426	936	65.3	3.52	5.83	3.02	3.04	.29
Average	1507	923	65.5	3.59	5.72	3.17	3.14	.28
Without Cover Crop								
Control	1367	875	63.8	3.85	6.14	2.45	3.35	.24
NH_4NO_3	1683	1126	66.6	4.17	7.10	2.10	3.65	.24
Manure	1759	1176	66.9	4.17	6.30	3.21	3.49	.21
Vetch	1678	1107	65.7	4.00	6.44	2.65	3.35	.24
Average	1609	1071	65.7	4.05	6.49	2.60	3.46	.23
*LSD .05	100	71	1.2	0.30	0.52	0.38	0.18	.03

* The LSD indicated is for comparison between subplots within the same main plot but is approximately equal to the LSD for interaction between main plot and subplot treatments. There was a significant interaction for yield, acre value, and percent P. There were significant differences between main plots for all data except value per 100 pounds.

TABLE 11.–Soil Test Results for Continuous Tobacco Plots Receiving 110 Pounds P_2O_5 and 165 Pounds K_2O Per Acre Per Year.

Year	pH	Organic Matter	P	K
		Percent	Lbs./A	Lbs./A
1958	5.7	2	98	111
1962	5.6	2	152	222

The fertilizer application consisted of 1000 pounds of a 5-10-15 fertilizer and an additional 50 pounds of N per acre.

Results and Discussion

The combination of row and interrow spacings which were studied and the results for 2 years are shown in Table 12. The conventional spacing (40 inches between rows with plants 18 inches apart in the row) serves as a basis of comparison for other treatments. Increasing the row width to 50 inches without changing the interrow spacing resulted in decreased yields and acre value. However, yield and acre value could be maintained by placing the plants closer together in the row. Both 12 and 14-inch interrow spacings were equal to the conventional spacing. The 50" x 18" and the 60" x 12" spacings produced lower yields than the other spacings. The plot population is the same for the 60" x 12" spacing as for the conventional 40" x 18" spacing but the former treatment produced the lowest yield. Within limits, yields of tobacco can be maintained when row widths greater than 40 inches are used by decreasing the interrow spacing.

Value per 100 pounds was not affected by the variations in spacings.

TABLE 12.–Averages of Yield, Acre Value, and Value Per 100 Pounds of Tobacco Grown with Several Row and Interrow Spacings During the Years 1960-1961.

Row Spacing	Interrow Spacing	Yield	Value	Price
Inches	Inches	Lbs./A	$/A	$/100 Lbs.
40	18	1917	1317	68.7
50	12	1900	1326	69.8
50	14	1875	1296	69.2
50	18	1703	1164	68.4
60	12	1578	1083	68.8
LSD .05		106	79	N.S.
.01		144	107	

SUMMARY AND CONCLUSIONS

Fertility experiments with burley tobacco have been conducted at the Southern Substation near Ripley, Ohio, over the past five years.

The optimum nitrogen fertilization rate was 120 pounds per acre from the standpoint of yield, acre value, and quality. This rate of application increased the yield approximately 400 pounds per acre over the control treatment. A higher rate of N did not further increase the yield and tended to decrease quality based on the appearance of the leaf.

Yield increases were obtained for the 60 and 80 pound ratee of P_2O_5 and K_2O, respectively, when the soil test indicated low to medium low amounts of available P and K. There was no further yield response to higher rates of either P or K. However, K applications tended to increase the quality of the leaf using value per 100 pounds as an index. These increases in quality were not sufficient, however, to increase the acre value of the crop.

Nitrogen application increased the percentages of N, alkaloids, Ca, and Mg and decreased the amount of P in the leaf. Potassium application decreased the percentages of Ca, Mg, and P in the leaf while increasing K. A basic application of 1100 pounds of 5-10-15 mixed fertilizer with an additional 67 pounds of N per acre appeared to be adequate for an optimum yield and quality of tobacco even for soils testing low in available P and K. This rate of fertilization also increased the levels of available P and K in the soil.

In continuous culture experiments a cover crop has not been an effective means to maintain yields. When a cover crop was used manure was superior to an equivalent amount of N (to that found in the manure) supplied as a commercial fertilizer or as a vetch crop. In the absence of a cover crop the commercial fertilizer produced as high a yield as the manure treatment.

A row X interrow spacing of 50" x 12" produced as high a yield as the conventional 40" x 18" spacing. Increasing the row or interrow spacing beyond 50" x 12" tended to decrease the yield.

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